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Childhood Cancer Risk Analysis with Integrated Decision-Making Method

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Abstract: The top cause of death for children worldwide, particularly in low- and middle-income nations, is cancer in childhood. The nation in which they reside has a significant impact on their chances of survival. In high-income nations, the likelihood of treating childhood cancer is greater than 80%, compared to just 45% in low- and middle-income nations. Effective, evidence-based therapy combined with compassionate care is the most effective strategy to lessen the impacts of childhood cancer. The current risk assessment procedure will be addressed, and a new risk evaluation method will be presented. In order to cope with ambiguity in the risk assessment process for pediatric cancer, the suggested strategy makes use of MCDM, which has a hybrid structure made up of the Neutrosophic AHP and Fermatean Fuzzy AHP methods.

Keywords: Childhood cancer, cosine similarity, FF-AHP, NF-AHP, risk analysis

1 Introduction

Childhood cancer is the leading cause of mortality for children globally, particularly in low- and middle-income countries. The nation in which they reside has a significant impact on their chances of survival. In high-income nations, the likelihood of treating childhood cancer is greater than 80%, compared to just 45% in low- and middle-income nations. This discrepancy in cure rates is caused by a variety of variables, including late diagnosis and cancer detected in its advanced stages due to a lack of resources, the expense of therapy (which is higher in the later stages of the disease), inaccurate diagnosis, and unsuitable treatment. If low- and middle-income nations gain access to vital drugs and technology, the survival rate could rise. In general, effective, evidence-based therapy combined with compassionate care is the most effective strategy to lessen the impacts of childhood cancer.

If it is detected early and the proper therapy is given right away, the chances of curing children's cancer and the cost of treatment with less suffering can be improved. A proper diagnosis is necessary for effective treatment of children's cancer with the appropriate measures, which may include operations, radiation, and chemotherapy. The following three factors should be considered for early diagnosis:

- It is important for parents to be aware of children's cancer so they can spot the signs and seek medical attention.
- To offer the best care, the medical expert must be qualified to look at the situation right away.
- The patient is given the appropriate care at the appropriate time.

Even with the least degree of physical and financial pain, if cancer is discovered early enough, there is a greater possibility of recovery and survival. With the aid of qualified doctors, low- and middle-income nations should launch parental education initiatives to help parents react quickly if their children exhibit signs. Both non-governmental groups and civil society must work together to complete this mission. The World Health Organization started a global program on childhood cancer in 2018. They offered the government professional advice and support as part of this campaign in order to keep up high-quality programs to combat childhood cancer. By 2030, they hope to enhance childhood cancer survival rates, which should be at least 60%.

Any decision-making process must account for imprecision. To deal with the ambiguous environment of collective decision-making, many tools and strategies have been proposed. Fermatean fuzzy sets (FFS) [14] are one of the newest techniques for coping with uncertainty. Compared to the intuitionistic fuzzy sets(IFS) [3] and Pythagorean fuzzy sets(PFS) [18], [19], which are extensions of Zadeh's fuzzy set [20], these sets offer a larger range of applications. Recently, FFs have inspired many studies.([2], [8], [9], [10], [11], [12], [15], [16]).

Smarandache [17] extended the idea of IFSs to create neutrosophic sets(NS), which offer a fresh perspective on ambiguity, imprecision, consistency, and vagueness. Smarandache [3] defined a NS by its three ingredient: truth membership, indeterminacy membership, and falsity membership. Smarandache also added the degree of indeterminacy or neutrality as a new and independent ingredient of FSs. The intuitionistic neutrosophic soft set has been defined and examined some properties by Broumi and Smarandache [6].

The AHP improved by Saaty [13] is among the most widely used MCDM techniques. Researchers can methodically specify the weight of the criteria and alternatives. The traditional AHP approach has been expanded into a number of fuzzy variations due to inadequate information and ambiguity. Since 2013, NSs have been widely utilized in decision-making procedures. To the best of our knowledge, Abdel-Basset et al. [1] and

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Radwan et al. [4] both published works on NF-AHP. Both interval-valued NF-AHP alone and interval-valued NF-AHP combined with a cosine similarity measure are presented by Boltürk and Kahraman [5]. Based on Bhattacharya's distance, Broumi and Smarandache [7] presented a new cosine similarity between two interval-valued NSs. The FF-AHP was first introduced by Alkan et al. [2].

A measure of similarity between two vectors of n dimensions using the cosine of the angle between them is known as cosine similarity. It compares simply the direction of two vectors to determine how similar they are. Each user is viewed as a vector of prior judgments in this similarity. The cosine value of the angle between the two vectors in this instance expresses how similar the two vectors are to one another. By dividing the inner product of the two vectors by the product of their lengths, the cosine similarity formula determines the angle between the two vectors. The closeness between two users in cosine similarity ranges from 0 to 1. The likelihood of users increases as the result gets closer to 1. A closeness in cosine similarity between two users does not mean that they rate things similarly; rather, it means that there is a consistent correlation between their evaluations. The following formula is used to express the cosine similarity between two vectors, d_i and d_j: $sim_{cos}(d_i, d_j) = \frac{\vec{d_i}.\vec{d_j}}{\|\vec{d_i}\|.\|\vec{d_j}\|}$.

The originality: Risks according to childhood cancer are prioritized using an MCDM approach. The fuzzy approach employed in this work captures the erroneous information that distinguishes decision-makers assessments. In conclusion, this study provides further insight into the specific risk landscape for childhood cancer in the future. The strategy put forward in this study offers a sophisticated and enhanced manner of managing uncertainty in risk prioritization. For MCDM, a hybrid technique based on FF-AHP, NF-AHP, and Cosine Similarity procedures has been suggested in order to give physicians more dependable options. The suggested approach is a helpful tool that may be used to solve various complicated choice issues with many competing criteria because of its adaptable structure.

2 Method

U, the initial universe set, will be used as a symbol throughout the article.

The FFS $\mathcal{F}$ is shown by $\mathcal{F} = \{(u, \zeta_{\mathcal{F}}(u), \eta_{\mathcal{F}}(u)) : u \in U\}$, where $\zeta_{\mathcal{F}} : U \to [0,1]$ and $\eta_{\mathcal{F}} : U \to [0,1]$ and the inequality $0 \leq \zeta^3_{\mathcal{F}}(u) + \eta^3_{\mathcal{F}}(u) \leq 1$ [14] is valid. It is defined as $\theta_{\mathcal{F}}(u) = \sqrt[3]{1 - (\zeta^3_{\mathcal{F}}(u) + \eta^3_{\mathcal{F}}(u))}$ degree of indeterminacy of u to $\mathcal{F}$.

Take three FFSs $\mathcal{F} = \{\zeta_{\mathcal{F}}, \eta_{\mathcal{F}}\}$, $\mathcal{F}_1 = \{\zeta_{\mathcal{F}_1}, \eta_{\mathcal{F}_1}\}$ and $\mathcal{F}_2 = \{\zeta_{\mathcal{F}_2}, \eta_{\mathcal{F}_2}\}$. Then, some operations as follows [14]:

i. $\mathcal{F}_1 \cap \mathcal{F}_2 = (\min\{\zeta_{\mathcal{F}_1}, \zeta_{\mathcal{F}_2}\}, \max\{\eta_{\mathcal{F}_1}, \eta_{\mathcal{F}_2}\})$;
ii. $\mathcal{F}_1 \cup \mathcal{F}_2 = (\max(\zeta_{\mathcal{F}_1}, \zeta_{\mathcal{F}_2}), \min(\eta_{\mathcal{F}_1}, \eta_{\mathcal{F}_2}))$;
iii. $\mathcal{F}^t = (\eta_{\mathcal{F}}, \zeta_{\mathcal{F}})$;
iv. $\mathcal{F}_1 \boxplus \mathcal{F}_2 = \left(\sqrt[3]{\zeta^3_{\mathcal{F}_1} + \zeta^3_{\mathcal{F}_2} - \zeta^3_{\mathcal{F}_1}\zeta^3_{\mathcal{F}_2}}, \eta_{\mathcal{F}_1}\eta_{\mathcal{F}_2}\right)$;
v. $\mathcal{F}_1 \boxtimes \mathcal{F}_2 = \left(\zeta^3_{\mathcal{F}_1}\zeta^3_{\mathcal{F}_2}, \sqrt[3]{\eta^3_{\mathcal{F}_1} + \eta^3_{\mathcal{F}_2} - \eta^3_{\mathcal{F}_1}\eta^3_{\mathcal{F}_2}}\right)$;
vi. $\mu\mathcal{F} = \left(\sqrt[3]{1 - (1 - \zeta^3_{\mathcal{F}})^{\mu}}, \eta^{\mu}_{\mathcal{F}}\right), \quad \mu > 0$;
vii. $\mathcal{F}^{\mu} = \left(\zeta^3_{\mathcal{F}_1}, \sqrt[3]{1 - (1 - \eta^3_{\mathcal{F}})^{\mu}}\right), \quad \mu > 0$.

Definition 1. *For two interval numbers $t = [t^-, t^+]$ and $s = [s^-, s^+]$, the operations*

$$t + s = [t^- + s^-, t^+ + s^+], \quad t - s = [t^- - s^+, t^+ - s^-],$$
$$t^n = [(t^-)^n, (t^+)^n], \textit{here} \quad t^- \geq 0, \quad n \in \mathbb{N}.$$

are called interval arithmetic.

The set $A = \{u, T_A(u), I_A(u), F_A(u) : u \in U\}$ is called a NS, where $T_A(u), I_A(u), F_A(u) : U \to [0,1]$ and $0 \leq T_A(u)^3 + I_A(u)^3 + F_A(u)^3 \leq 3^+$.

Table 1 Scale for FF-AHP [2]

Linguistic Terms	ζ_L	ζ_U	η_L	η_U
Certainly low importance(CLI)	0	0	0.9	1
Very low importance(VLI)	0.1	0.2	0.8	0.9
Low importance(LI)	0.2	0.35	0.65	0.8
Below average importance(BAI)	0.35	0.45	0.55	0.65
Average importance(AI)	0.45	0.55	0.45	0.55
Above average importance(AAI)	0.55	0.65	0.35	0.45
High importance(HI)	0.65	0.8	0.35	0.2
Very high importance(VHI)	0.8	0.9	0.1	0.2
Certainly high importance(CHI)	0.9	1	0	0
Exactly equal(EE)	0.1965	0.1965	0.1965	0.1965

For the FF-AHP:

Step 1: Create the pairwise comparison matrix $\mathcal{R} = (r_{ik})_{m \times m}$ using Table 1 to reflect the experts' assessments.

Table 2 Scale for NF-AHP

Linguistic Terms	Neutrosophic values
Equal Importance	([0.5, 0.5], [0.5, 0.5], [0.5, 0.5])
Weakly More Importance	([0.5, 0.6], [0.35, 0.45], [0.4, 0.5])
Moderate Importance	([0.55, 0.65], [0.3, 0.4], [0.35, 0.45])
Moderately More Importance	([0.6, 0.7], [0.25, 0.35], [0.3, 0.4])
Strong Importance	([0.65, 0.75], [0.2, 0.3], [0.25, 0.35])
Strongly More Importance	([0.7, 0.8], [0.15, 0.25], [0.2, 0.3])
Very Strong Importance	([0.75, 0.85], [0.1, 0.2], [0.15, 0.25])
Very Strongly More Importance	([0.8, 0.9], [0.05, 0.1], [0.1, 0.2])
Extreme Importance	([0.9, 0.95], [0.0, 0.05], [0.05, 0.15])
Extremely High Importance	([0.95, 1.0], [0.0, 0.0], [0.0, 0.1])
Absolutely More Importance	([1.0, 1.0], [0.0, 0.0], [0.0, 0.0])

Step 2: Using the bottom and upper values of the membership and non-membership functions, calculate the differences matrix $\mathcal{D} = (\delta_{ik})_{m\times m}$ using:

$$\delta_{ikL} = \mu^3_{ikL} - \nu^3_{ikU} \quad (1)$$

$$\delta_{ikU} = \mu^3_{ikU} - \nu^3_{ikL}. \quad (2)$$

Step 3: Obtain the interval multiplicative matrix $\mathcal{S} = (\sigma_{ik})_{m\times m}$ by using:

$$\sigma_{ikL} = \sqrt{1000^{\delta_{ikL}}} \quad (3)$$

$$\sigma_{ikU} = \sqrt{1000^{\delta_{ikU}}}. \quad (4)$$

Step 4: Compute the determinacy value $T = (\rho_{ik})_{m\times m}$ of the r_{ik} by employing:

$$\rho_{ik} = 1 - (\mu^3_{ikL} - \nu^3_{ikU}) - (\mu^3_{ikU} - \nu^3_{ikL}). \quad (5)$$

Step 5: To get the weights matrix before $\mathcal{Z} = (\zeta_{ik})_{m\times m}$ normalization, multiply the determinacy values by the $\mathcal{S} = (\sigma_{ik})_{m\times m}$ matrix using:

$$\zeta_{ik} = \left[\frac{\sigma_{ikL} + \sigma_{ikU}}{2}\right] \rho_{ik}. \quad (6)$$

Step 6: Compute the normalized priority weights ω_i by adpting Equation 7:

$$\omega_i = \frac{\sum_{k=1}^{m} t_{ik}}{\sum_{i=1}^{m}\sum_{k=1}^{m} t_{ik}}. \quad (7)$$

For the NF-AHP:

Step 1: Find the neutrosophic rating scale using interval values.

Step 2: Divide the issue into a hierarchy of objectives, criteria, sub-criteria, and alternatives.

Step 3: Use interval-valued neutrosophic sets to build the pairwise comparison matrices ($\tilde{P}$). The deneutrosophication equation has been used to assess the consistency of the pairwise comparison matrices:

$$D(x) = \left(\frac{T^L_x + T^U_x}{2} + \left(1 - \frac{I^L_x + I^U_x}{2}\right) * I^U_x - \left(\frac{F^L_x + F^U_x}{2}\right) * (1 - F^U_x)\right) \quad (8)$$

for a collection of IV-Neutrosophic number $\tilde{x}_j = ([T^L_x, T^U_x], [I^L_x, I^U_x], [F^L_x, F^U_x])$, $(j = 1, 2, \cdots, n)$. It follows that if the neutrosophic pairwise comparison matrix is consistent, so is the deneutrosophicated pairwise comparison matrix. There will be provided pairwise comparison matrices for the criteria and options in relation to the aim.

Step 4: Utilize the proposed interval-valued neutrosophic evaluation scale to determine the normalized weights of the various criteria.

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Step 4.1: Sum the values in each column as in

$$\tilde{S_{ij}} = \left(\left[\sum_{k=1}^{m} T_{k_j}^L, \sum_{k=1}^{m} T_{k_j}^U \right], \left[\sum_{k=1}^{m} I_{k_j}^L, \sum_{k=1}^{m} I_{k_j}^U \right], \left[\sum_{k=1}^{m} F_{k_j}^L, \sum_{k=1}^{m} F_{k_j}^U \right] \right). \quad (9)$$

Step 4.2: In Equation 9, choose the highest limit for each parameter. Then, divide each term by the appropriate element to get $\tilde{N_{ij}}$:

$$\tilde{N_{kj}} = \left(\left[\frac{T_{k_j}^L}{\sum_{k=1}^{m} T_{k_j}^U}, \frac{T_{k_j}^U}{\sum_{k=1}^{m} T_{k_j}^U} \right], \left[\frac{I_{k_j}^L}{\sum_{k=1}^{m} I_{k_j}^U}, \frac{I_{k_j}^U}{\sum_{k=1}^{m} I_{k_j}^U} \right], \left[\frac{F_{k_j}^L}{\sum_{k=1}^{m} F_{k_j}^U}, \frac{F_{k_j}^U}{\sum_{k=1}^{m} F_{k_j}^U} \right] \right). \quad (10)$$

Step 4.3: To obtain the neutrosophic priority vector of the choices as in Equation 11, compute the average of each row.

$$\tilde{\omega_A} = \left(\frac{\left[\sum_{k=1}^{m} \frac{T_{k_j}^L}{\sum_{k=1}^{m} T_{k_j}^U}, \sum_{k=1}^{m} \frac{T_{k_j}^U}{\sum_{k=1}^{m} T_{k_j}^U} \right]}{m}, \frac{\left[\sum_{k=1}^{m} \frac{I_{k_j}^L}{\sum_{k=1}^{m} I_{k_j}^U}, \sum_{k=1}^{m} \frac{I_{k_j}^U}{\sum_{k=1}^{m} I_{k_j}^U} \right]}{m} \frac{\left[\sum_{k=1}^{m} \frac{F_{k_j}^L}{\sum_{k=1}^{m} F_{k_j}^U}, \sum_{k=1}^{m} \frac{F_{k_j}^U}{\sum_{k=1}^{m} F_{k_j}^U} \right]}{m} \right) \quad (11)$$

Step 4.4: To produce neutrosophic weights vectors for each choice, repeat the previous stages with regard to each criterion. To get the priority weights of the criterion, the same procedure is done.

Step 5: Build the $\tilde{\Psi}$ matrx whose rows are the weights of the alternatives $(\tilde{\omega_{A_i}})$ and the columns are the weights of the criteria $(\tilde{\omega_{C_j}})$ to get the final combined priority weights.

Step 6: Equation 12 can be used to determine the final combined interval-valued neutrosophic weights of the alternatives.

$$\begin{aligned} \tilde{\Psi_A} &= \left(\left[T_{\omega_{C1}}^L, T_{\omega_{C1}}^U \right], \left[I_{\omega_{C1}}^L, I_{\omega_{C1}}^U \right], \left[F_{\omega_{C1}}^L, F_{\omega_{C1}}^U \right] \right) \left(\left[T_{\omega_{A1}}^L, T_{\omega_{A1}}^U \right], \left[I_{\omega_{A1}}^L, I_{\omega_{A1}}^U \right], \left[F_{\omega_{A1}}^L, F_{\omega_{A1}}^U \right] \right) \\ &+ \left(\left[T_{\omega_{C2}}^L, T_{\omega_{C2}}^U \right], \left[I_{\omega_{C2}}^L, I_{\omega_{C2}}^U \right], \left[F_{\omega_{C2}}^L, F_{\omega_{C2}}^U \right] \right) \left(\left[T_{\omega_{A2}}^L, T_{\omega_{A2}}^U \right], \left[I_{\omega_{A2}}^L, I_{\omega_{A2}}^U \right], \left[F_{\omega_{A2}}^L, F_{\omega_{A2}}^U \right] \right) \\ &+ \cdots + \left(\left[T_{\omega_{Cn}}^L, T_{\omega_{Cn}}^U \right], \left[I_{\omega_{Cn}}^L, I_{\omega_{Cn}}^U \right], \left[F_{\omega_{Cn}}^L, F_{\omega_{Cn}}^U \right] \right) \left(\left[T_{\omega_{An}}^L, T_{\omega_{An}}^U \right], \left[I_{\omega_{An}}^L, I_{\omega_{An}}^U \right], \left[F_{\omega_{An}}^L, F_{\omega_{An}}^U \right] \right). \end{aligned} \quad (12)$$

Step 7: To get the crisp weights of alternatives, use Equation 8's deneutrosophication formula.

Step 8: Normalize the crisp weights of alternatives.

Step 9: Choose the option with the most weight after ranking the alternatives.

3 Childhood Cancer Risk Assessment

3.1 Major Factors of Childhood Cancer

Many studies have tried to identify the causes of childhood cancer. Some factors are related to the environment, such as radiation exposure and chemical exposure. Some are lifestyle-related, such as drugs, alcohol, cell phone use, and smoking. Some kids receive DNA alterations from a parent that raise their risk of developing a particular kind of cancer. Here we list possible risk factors for childhood cancer with a small description of each factor.

Gender (S1): Gender can be male or female. Age (S2): The age of a child is considered between 0 and 19 years.Height (S3): The height of a child. BMI (S4): The body mass index (BMI) is a measure of body fat according to height and weight. Drugs (S5): A medication is a drug used to diagnose, cure, treat, or prevent disease. Alcohal (S6): It is a substance that contains the recreational drug ethanol, alcohol is made by fermentation of fruits, grains, or any source of sugar. Cell Phone Usage (S7): The use of cell phones on a daily basis. Pagets Disease (S8): This bone condition prevents the body's regular recycling process, which sees new bone tissue progressively replace old bone tissue. Compromised bones may grow weak and deformed over time as a result of the disease. Genetic Disposition (S9): There is an increased chance of acquiring a specific disease based on a person's ancestral genes. Smoking (S10): The habit of inhaling and exhaling tobacco or drug smoke. Blood Disorder (S11): These are conditions that affect the blood's ability to function. Birth Defects (S12): It is a disease that, despite its cause, is present at birth. Birth defects can appear as disabilities that can be physical, mental, or developmental in nature. Immunity (S13): Immunity is the capability ofmulti-cellular organisms to resist harmful microorganisms. Auto Immune Diseases (S14): It is a disease in which your immune system unintentionally attacks your body. Certain Syndromes(S15): Any syndrome already present in children such as Down syndrome, Li-Fraumeni syndrome, etc. Race (S16): Identification of a group of people. Certain Radiation Exposure (S17): Exposed to certain electromagnetic radiation, or living in the vicinity of a source of electromagnetic radiation. Certain Chemical Exposure (S18): Exposure to certain chemicals or polluted groundwater used for drinking. Socioeconomic Status (S19): A family's financial status in society.

3.2 Types of Childhood Cancers

Children and teenagers tend to get different types of childhood cancers. The most common childhood cancers are discussed below:
Leukemia (D1): It is bone marrow and blood cancer. Twenty-eight percent of childhood cancer cases fall into this category. Brain and spinal cord tumors (D2): The second most common cancer in children is the brain and spinal cord cancer. In this type of cancer, abnormal growth in tissues of the brain and spinal cord is seen causing headache, nausea, vomiting, blurred vision, and difficulty in walking and holding objects.

About 26 children develop this type of cancer every year. Neuroblastoma (D3): Neuroblastoma begins in the early forms of nerve cells seen in a developing egg or fetus. About 6 percent of cancers in adolescents are neuroblastomas. This type of cancer occurs in newborns and adolescents. It is uncommon in children over 10 years of age. Neuroblastomas mostly occur in and around the adrenal glands. However, neuroblastomas can develop in other areas of the stomach and ribs, neck, and near the spine where there are clusters of nerve cells. Wilms Tumor (D4): Wilms' tumor begins in one or, rarely, both kidneys. It is usually found in children around 3 to 4 years of age and is rare in more mature children and adults. Wilms' tumor accounts for around 5 percent of childhood cancers. Its symptoms are fever, pain, nausea, or loss of appetite. Lymphomas (D5): It is a disease that attacks infection-fighting cells in the immune system. These cells are called lymphocytes. These cells are found in the lymph nodes, spleen, thymus gland, bone marrow, and other parts of the body. In this disease, abnormal growth of lymphocytes has been observed. Symptoms include weight loss, fever, sweats, fatigue, and lumps under the skin in the neck, armpits, or groin area. Retinoblastoma (D6): This type of cancer is related to the eyes. It is a rare type of cancer in which a child could not distinguish the colors of light, also had impaired vision and sensitive eyes. The pupil of the eyes becomes large. Rhabdomyosarcoma (D7): It is an intrusive and very dangerous cancer that originates from skeletal muscle cells. It is widely believed to be a childhood disease as the vast majority of cases found are under the age of 18. It is about 3 percent of childhood cancers. Bone Cancer (D8): This type of cancer usually occurs in older children. This type of cancer causes severe bone pain all the time. The bones become weak and can also be broken. In some cases, weight loss is also observed.

3.3 New Method

The new method involves the FF-AHP and NF-AHP methods. First, the FF-AHP steps are given:

Step 1: Establish the criteria and options before building the hierarchical structure.
Step 2: Consult the partners to organize these risks into a hierarchy, then convert the issue into a hierarchy of objectives and standards.
Step 3: Create binary comparison matrices for the criterion based on Table 1's range-valued sets.
Step 4: Applying the suggested interval valuation scale, determine the normalized criteria weights:
Step 4.1: The matrix's values are gathered for each of its columns.
Step 4.2: Each parameter is divided by the highest value chosen after choosing the maximum values for each parameter.
Step 4.3: In order to determine the priority vectors, compute the average of each sequence.
Step 4.4: Each criterion is subjected to the same procedures as before, and weight vectors are produced for each. To get the priority weights for each criterion, these steps were repeated.
Step 5: Utilizing the prioritized weights that were collected, compute the cosine similarity between each alternative pair.
Step 6: The appropriate AHP score is determined using the linear regression algorithm.
Step 7: Based on the conventional AHP procedures, alternative weights were obtained.
Step 8: The probability and severity criteria of the alternatives are graded in accordance with alternative weights to enable the use of the L matrix approach.
Step 9: Utilize the grades you have earned to apply the L matrix approach.

Second, the NF-AHP steps are given:

Step 1: Define the neutrosophic numbers, which are utilized in the proposed neutrosophic fuzzy AHP approach to compare various criteria and correlate to the 1–9 Saaty scale.
Step 2: Determine the decision-making problem's criteria, sub-criteria, and options. Next, create a hierarchy for the problem under consideration.
Step 3: By comparing each criterion and sub-criterion pairwise, you may determine the neutrosophic preference. Compare the options under each criterion or sub-criterion that are provided in accordance with the assessments of the experts based on Table 2.
Step 4: Construct the neutrosophic preference connection and ensure that each paired comparison is consistent. Utilizing the prioritized weights that were collected, compute the cosine similarity between each alternative pair.
Step 5: Give the results of the calculation for each preference relation's neutrosophic relative weight.
Step 6: Rank the overall weights.

3.4 Evaluations

The primary criteria, sub-criteria, and alternatives will be included in the hierarchical structure that will be established about the risks of children cancer. Three doctors will assess these options and criteria for this study by building paired comparison matrices using linguistic concepts. A consistency ratio will be supplied along with pairwise comparison matrices that include linguistic phrases for the major criteria, sub-criteria, and alternatives. The steps of the created method will be presented but not shown due to space restrictions. According to the results obtained, the rating of the disease was found as $D_1 = 1$, $D_2 = 6$, $D_3 = 5$, $D_4 = 7$, $D_5 = 2$, $D_6 = 8$, $D_7 = 4$, $D_8 = 3$.

4 Conclusion

According to the World Health Organization (WHO), around 400,000 children are diagnosed with cancer each year and the rate of cure in low and middle-income countries is only 45 percent, which is highly unsatisfactory. To improve this percentage, WHO has launched a global initiative and provided appropriate professional guidance and resources. Their goal is to increase the survival rate up to sixty percent by the end of 2030. To help achieve this goal, we have proposed a novel model that allows doctors to diagnose the type of childhood cancer early so that appropriate treatment can be given at the right time. This ultimately reduces the physical and financial suffering of the patient and their parents. Our model takes nineteen symptoms as inputs and determines the type of cancer. We have used Fermatean fuzzy and Neutrosophic fuzzy decision-making techniques for diagnostic purposes.

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